Buried Object Scanning Technology Development

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LONG TERM GOALS

The long term goal of this program is to develop AUV sonar technology for detecting, imaging and classifying objects buried in or resting on the seabed.

OBJECTIVES

- To develop acoustic and signal processing technologies for detecting and visualizing objects buried in the seabed
- To develop and test low power sonar designs for deployment on AUVs
- To generate databases of buried target strengths, volume and surface scattering coefficients and sediment acoustic properties over a wide frequency range that can be used for sonar prediction modeling, mine burial modeling and sediment classification
- To develop acoustic models of sound interacting with the seafloor to provide a theoretical basis for signal processing techniques, predicting the detection of buried objects and sediment classification

APPROACH

Buried Object Detection

In order to develop a UUV sonar for detecting and imaging buried objects, the phenomenon of volume and surface scattering from the sediments, fluid / porous solid boundary-interacting acoustics, and the interaction of sound with elastic objects contained with a porous solid must be understood so that the signal levels and interference can be accurately calculated when estimating sonar performance of a particular design. A sonar system has been developed to measure those acoustic processes and to generate imagery of buried objects.

CEROS (DARPA) funded a compact version of the imaging sonar based on technology developed in this ONR program. This sonar uses a steerable transmit beam and a beamformer that provides across track and along track focusing. This sonar has a frequency range of 5-23 kHz. The 1 meter long by 1 meter wide towed vehicle contains a six element transmission array and eight line hydrophone arrays with 4 segments each. The sonar processor on the fish steers the transmission beam forward and aft to any selected angle of incidence and acquires 32 channels of reflection data which is sent to the topside

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processor via 100 Base T for display and storage. The sonars provides integrated video and acoustic data sets for measuring the impulse response of buried targets and the scattering interference from sediments in the vicinity of the targets. The compact sonar steers the transmission beam forward thereby substantially reducing the high scattering levels from the sediment water interface at near normal incidence that make it difficult to detect objects near the interface. Substantial testing and analysis was conducted on data collected by the buried object imaging sonar at a test range in Hawaii. Sonar performance was established and images of many types of objects buried in sand were generated including ordnance, pipes and cylinders.

Since the feasibility of detecting and imaging buried objects as small as ordnance shells was firmly established using the buried object image technology developed under this ONR program, a new effort was started in FY2000 to repackage the sonars for AUV operations. The repackaged sonars will be low power (<100W) for AUV deployment and will process data within the on board sonar processor so buried targets can be detected in real time and reported via acoustic modem to the surface support ship.

Dr. Schock and Jim Wulf are the principal engineers developing the sonar technology. They are assisted by two technicians and two graduate and three undergraduate students. Jim Wulf is a retired engineer from IBM who designed and tested the electronic components of BOSS. Gwen Quentin, a graduate student, is conducting simulations of reflection tomography from a moving sonar vehicle. Greg Rivalan, a graduate student is studying the effects of target diffraction on focusing.

WORK COMPLETED

Over the course of the past year, the following sonar components were designed and fabricated: 1) a 9 Watt 250 channel data acquisition system was designed and fabricated, 2) a sonar vehicle for testing the BOSS, 3) BOSS sonar arrays sections, and an underwater canister for housing BOSS electronics. Software for processing 250 channels of FM data was coded and bench tested. Low replication cost, low power requirements and small packaging form factors were driving design criteria. The sonar PC board design does not require a backplane so the sonar electronics have a variable form factor allowing repackaging into small AUVs such as the Bluefin 12 inch and the REMUS AUVs. Sonar power consumption is less than 100 Watts.

RESULTS

The plans for the upcoming year include completion of BOSS fabrication and sea testing, integration with CSS magnetometer electronics, development and testing of target detection and reflection tomographic imaging and image snippet generation code. Plans also include fabricating a second BOSS for installation into a Bluefin 12 ¾ inch vehicle. The tests will establish the performance of the sonars for detecting buried objects including buried mines in real time.

IMPACT/APPLICATIONS

The imaging sonars developed under this program can be used for finding mines and ordnance which are buried or lying on the seabed. Images can be used for target classification.

TRANSITIONS

FAU executed a licensing agreement with Edgetech, Inc. to manufacture the buried object imaging sonar

PUBLICATIONS

"Buried Object Scanning Sonar," Schock et al., *IEEE J. of Oceanic Engineering*., Special Issue on Autonomous Ocean Sampling Networks, October 2001 ,Vol. 26, No. 4, pp. 677-689.

"Buried Object Scanning Sonar For UUV Deployment," S. G. Schock, *Proceedings, Unmanned Systems*, July 2001, p.2393.